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SMALL-SCALE BRICK PRODUCTION (NIGERIA)

EVALUATION REPORT - OCTOBER 1992

Prepared for

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

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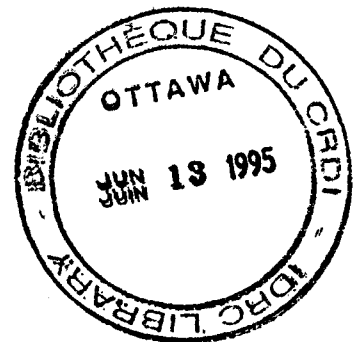
by

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INTRODUCTION

Nigeria is a country with enormous social and economic problems. With a burgeoning population and a general exodus from rural to overcrowded urban areas, there is a pressing need for many changes. Rural dwellings are generally of poor quality, most frequently of impermanent "wattle-and-daub" construction with corrugated metal roofing and many of the urban dwellings are little, if any, improvement. Although clay is generally in abundance, the use of fired-clay products, a preferred building material, is practically non-existent in the rural setting. In 1987, the International Development Research Centre (IDRC) in Ottawa approved a proposal for the development of a small-scale brick production technology having as its general objective an increase in the accessibility of rural, semi-urban and urban dwellers to adequate housing by reducing the cost of walling materials and to create job opportunities through the creation of small-scale brick production plants.

Participating partners in this research and development are the Nigerian Building and Road Research Institute (NBRRI) in Nigeria and the Prairie Masonry Research Institute (PMRI) in Edmonton. Other participating agencies are the Nigerian Federal Institute of Industrial Research, Oshadi (FIIRO) and IXL Industries, Edmonton.

The project has now proceeded through various stages of development, and in 1991 IDRC commissioned an independent evaluation, this being the subject of the present report. The report is based on:

- A review of the Project Proposal and relevant files at the IDRC offices in Ottawa in June 1991;
- a review of a joint NBRRI/IXL report on a laboratory study of the ceramic properties of three Nigerian clays;
- a review of the PMRI design, construction and operating document for a down-draft kiln;
- a review of the site plan for the pilot brick production plant at Ikabigbo-Ugbenor;
- an examination of project files and the 15/7/88 - 18/2/92 summary of expenditures at NBRRI; and
- a 7 October 1992 meeting with Dr. A. O. Madador, Director of NBRRI, and his staff;

- 5/6/7 October 1992 meetings with Mr. A. O. Dirisu, Head of the Building Materials Section of NBRRI and Director of small-scale brick production project in Nigeria;
- 5/6 October visit to the laboratories at NBRRI; and
- 1991 and 1992 discussions with Dr. M.A. Hatzinikolas, Executive Director of PMRI, and with Mr. R. Pacholok, formerly of IXL Industries.

This evaluation report follows the general format outlined in the Terms of Reference of the Consulting Contract (Appendix III). While all terms are addressed, particular attention is paid to item f) that deals with practical accomplishments. A project progress summary provided by NBRRI is included as Appendix I, and some relevant photographs are included in Appendix II.

A. RESEARCH METHODOLOGY

The sequence of research and development followed in this project is logical: from the initial problem identification, through the sampling of clay deposits and characterization studies of the physical properties, to the design/selection of a suitable kiln, to its construction. It is perhaps unfortunate that the principal Nigerian researcher, an analytical chemist, was restricted to the study of the physical properties only of the clays since IXL normally conducts testing for physical properties only, and the NBRRI chemical laboratory is totally inadequate to perform full chemical characterization studies.

The main novelty of this project lies in the adaptation of the kiln fire boxes for alternative sources of fuel. In this particular instance, the design of drip plates for the fire boxes to utilize waste engine oil is receiving particular attention and a suitable configuration is being developed. Another novel feature is the incorporation of laterite into the clay mix for colour control.

B. CONTRIBUTION TO NIGERIAN RESEARCH CAPABILITY

Mr. A. O. Dirisu's stay in Canada has provided him with valuable experience to apply to Nigerian research into brick and tile production. Also, and importantly for all IDRC projects, this project provides the medium for local development of research potential. The NBRRI staff working on this project consist of overall direction by the Director of UBRRI with a doctoral degree, two M.Sc. and one B.Sc. holders and about four technologists. Not all of these personnel are assigned full time to the project. Mr. Dirisu, the Director of the IDRC project, is an analytical chemist with a master's degree.

C. PARTICIPATING RESEARCH INSTITUTIONS

NBRRI has been in existence for about fifteen years, with about 80% of its research efforts being devoted to building and building materials. Its concrete and brick laboratories are just adequate to conduct the testing for physical properties normally associated with engineering materials, but the chemistry laboratory is totally inadequate for the chemical characterization studies that form a complementary part of the full understanding of fired clay products. Nor, apparently, are adequate chemical testing facilities available in Nigeria. As a result, it is unfortunate that Mr. Dirisu, an analytical chemist, has little opportunity to use his specialized knowledge, and I would recommend that he be given the opportunity to conduct chemical characterization studies of Nigerian clays abroad.

PMRI is nationally (i.e. in Canada) and internationally acknowledged for the excellence of its masonry research leading to practical technology. Its links with the Universities of Alberta, Saskatchewan and Manitoba provide ready access to the most modern testing facilities, both scientific and technical.

Both NBRRI and PMRI report satisfaction with the support each receives from the other, and both appear to be dedicated to the project.

D. COLLABORATION

As noted in item C, NBRRI and PMRI have established good working relations and have collaborated well on this project. In the early stages Mr. Dirisu (NBRRI) was involved, in Canada, in the clay characterization studies, and in the kiln design - although the latter responsibility lay principally with PMRI. At the present stage of project development, prime responsibility lies with NBRRI, and therefore with Mr. Dirisu. Communication between the two institutions continues.

E. TRAINING ACTIVITIES

Although there have been delays in the project, as noted in item F below, various training activities of relevance to the project have proceeded. For example, NBRRI, in cooperation with other Nigerian agencies, have already started a training program to introduce brick technology and dissemination of information. However, these activities will be pursued more vigorously once the bricks are available for the construction of a building.

F. ACHIEVEMENTS

The specific objectives of this project, as taken from p3 of the Project Proposal, are as follows:

- i) to evaluate available clays from three different regions in the country, selected from rural and para-urban areas, as to their suitability for brick;
- ii) to select an optimum brick size and design its core configuration;
- iii) to design and construct a low-cost brick forming machine including its accessories which is simple, light, efficient and can be manufactured from available local materials;
- iv) to design and construct a low-cost, energy-efficient, down-draft kiln suitable for burning available coal and/or agricultural waste;
- v) to construct a kiln for manufacturing lime to be used in replacing cement in mortar preparation;

- vi) to evaluate the physical properties of the burned clay units and wall assemblies constructed with the brick units and lime mortar;
- vii) to design and evaluate a low-cost brick-making technology suitable for use in rural and semi-urban areas;
- viii) to demonstrate the technical and economic feasibility of fired brick and lime mortar by building a structure similar for use by the community; and
- ix) to hold necessary workshops to introduce the findings of the project and demonstrate to Nigerian entrepreneurs the economic viability of small-scale brick manufacturing units.

Guidelines are to be developed for the brick forming machine, for the design and construction of the brick and lime kilns, for the setting up of a plant with all its phases, and for the construction of buildings using the new brick units.

Objectives i) through iv) have now been successfully completed. A problem with brick surface deterioration has developed on one face of the brick kiln that requires investigation for remedial work to be undertaken. These, of course, were bricks from another source and not ones produced by the kiln. While the problem will provide some interesting investigation, it should not delay the project unduly. Objective iv) has changed direction and now includes waste motor oil as the cheapest and preferred fuel for the kiln - research is underway to develop the appropriate drip plates for the fire boxes using this fuel source.

Objective v): the lime kiln design is ready, but since construction awaits the production of bricks from the kiln, that aspect has yet to be completed. However, even without a lime kiln, the usual cement-based mortar can be used for brick construction until lime is being produced. Objective vi) also awaits the first run of bricks from the kiln before the product can be tested.

The brick-making technology of objective vii) is well underway. The site of the pilot plant at Ikabigbo-Ugbenor has been planned for a labour-intensive and efficient operation. A plan of the layout of a site is available, but an appropriate manual of instruction remains to be developed.

Objective viii) awaits the production of brick and the site of the display building and its design remains to be accomplished. Objective ix) remains to be undertaken although, as noted under item E, some training activities relating to brick have already started.

The 1987 grant approval was for a period of two years, which now in 1992 would suggest that the project has fallen far behind schedule. A number of factors contribute to this: the proposed project is ambitious and comprehensive and should have been allocated at least three years; the process has been bogged down from time to time by government bureaucracy; and a land claim dispute over the selection of a site for the pilot plant (which was eventually resolved by giving the site a hyphenated name to appease the claimants) resulted in a further loss of time. Given these delays, and the fact that the project in the first place should have been allocated more time, work is proceeding close to a reasonable schedule.

G. IMPACT ON DEVELOPMENT

There is no question that there is a critical need for low-cost building materials in Nigeria, and a need to provide a technology that will place a low-cost, good quality fired-clay product on the market for the construction of dwellings. Quite apart from the technological problems associated with developing this small-scale brick production, which are solvable, there have been some questions about public acceptance. In the first place, brick in the past has been used primarily in the construction of homes for the middle class and wealthy, so it is not perceived as an economical material for building. Also, regarding this pilot project, the particular clay at that location leads to a buff-coloured brick, whereas a red brick is the preferred colour. The question of wider acceptability of brick will have been given a boost by President Babagida who, in a recent speech, announced that bricks were to be used in all government buildings. The question of colour is being resolved by NBRRI through the addition of laterite, rather than more expensive iron oxide, to the clay.

While it is unlikely that the very poor rural or semi-urban dweller will start to build with bricks with an attached cost when the alternative, albeit less durable, is likely to have a much lower price tag, the more realistic aim of introducing small-scale brick production plants that are labour intensive should have a significant impact on the longer term development of better quality housing.

CONCLUDING COMMENTS

Although this project has encountered a number of problems in the course of its development, not an unexpected phenomenon in research and development, it is progressing reasonably well. There is no questioning the commitment of Mr. Andrew Dirisu and his staff to the project. I believe it would be to the advantage of this project or to a continuation of the project by Mr. Dirisu were given the opportunity to pursue the chemical analyses of Nigerian clays at a suitably equipped Canadian institution.

ACKNOWLEDGEMENT

I am particularly grateful to Mr. Andrew Dirisu of the NBRRI for his total cooperation and assistance during this evaluation.

APPENDIX I

PROJECT PROGRESS SUMMARY

Provided by

NBRRI



NIGERIAN BUILDING AND ROAD RESEARCH INSTITUTE

(FEDERAL MINISTRY OF SCIENCE & TECHNOLOGY)



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RE: SMALL SCALE BRICK PRODUCTION NIGERIA PROGRESS REPORT

The Institute has received letters from IDRC and yourself in respect of this visit. We believe your visit is to assess the extent of work done so far; and what remains to be done for the completion of the project. We also believe after your site visit and discussion with NBRRI'S Management as per the variation being sought, you will be in a good position to advise IDRC.

Presented below is the progress of work on the project from inception to date.

Commencement of Project

The memorandum of grant conditions was signed by the Institute in June 1988. The first instalment was released by IDRC in December 1988. The High Commission was advised to pay the Institute in Naira equivalent. Presentation was sent to the Council on why a dollar account was to be maintained for the project. The money was then paid in dollars in February 1989.

2. Preliminary Test On Clay Samples

Following the signing of the memorandum of grant condition and based on the methodology as contained in the proposal clay samples from three deposits were sent to Prairie Masonry Research Institute Edmonton for evaluation.

3. Training

Mr. A. O. Dirisu went to Canada (Prairie Masonry Research Institute, Edmonton) for training in clay characterisation. In Canada, he did the characterization and firing behaviour of the three samples at 1XL Central Laboratory in Medicine Hat with Mr. J. Shyna, the clays were evaluated and a recommendation was made on the most suitable clay for brick production.

A month was also spent at Esteran Brick Company to understudy the production process in a brick factory. During the training, some of the materials that were to be purchased by the Centre were procured. These include pick-up van, used gas fired furnace, Laboratory extruder, Refractory Brick and Mortar. To complement the fabrication of a brick making machine which was being designed by the Institute, a manual brick making machine was purchased from Belgium. Mr. A. O. Dirisu on his return to Nigeria, stopped over in Belgium to visit the Ceratec Company and to learn how to operate the machine.

3. Machine Design And Fabrication

A second generation brick making machine was developed from a Brazilian Torsa Machine. Prof. H. E. Enahoro of the Mechanical Engineering Department of University of Lagos did the design and fabrication of the machine. It took six months for the design and fabrication. The Institute produced five machines and tested them on the field. The machines are capable of producing stabilised bricks with the compacting effort of 3N/MM^2 stabilised blocks of compressive strength $1.86 - 1.92 \text{ N/MM}^2$ were produced.

The bricks produced by the machines were used in the construction of five prototype low cost houses in Federal Housing Authority FESTAC Estate in Lagos.

Kiln Design

A 45M^3 capacity Kiln was design by FMRL based on inputs from the Institute in terms of fuel to be used. It was agreed that used oil should be the fuel to be used. Drip plates and grates were purchased in Belgium together with the ceraman machine. At Grates, a demonstration on how to use the oil was carried out.

Clearing of Goods

As earlier mentioned, part of the funds to be administered by the Centre were used in the purchase of capital equipment and material. The following equipments and materials were purchased. Also the Institute bought some of the materials that were under their budget in Canada. These are shown below:

1. Nissan 2 WD	-	Purchased by Centre
2. Used Gas Kiln	-	" "
3. Laboratory Extruder		" "
4. Chemicals		NBRRI
5. Books		"
6. Refractory Bricks		Centre
7. Ceratic Machine and accessories		"
8. Clay Pulneriser		"

These items were shipped to Nigeria by the Centre. Prior to their shipment, the Institute wrote to the Federal Government for exemption of duty. It took a long time before the approval was obtained. On approval, we gave instruction that the goods be shipped with the feelings that once exempted all conditions were waved. During the process of clearing the goods, we were told that the goods should have been pre-inspected before shipment irrespective of the mode of purchase. To facilitate the release and to reduce demurrage, we were asked for form 'M' and request for destination inspection. The destination inspection was approved on the 19th of September, 1990. Despite the approval the inspection was not done until 12th December 1990. The demurrage was high on most of the consignments but the Institute absolved that burden as local expenses.

Site Preparation

Having collected all the equipment and materials we initiated plans for the execution of the next stage of the project which was site preparation. The Institute wrote to remind the Military Governor of former Bendel State (now Edo State) of their initial support and of our intention to start work on the site. Approval to enter the clay deposit was granted.

The survey work started in June, 1990 and the two communities bounding the clay lay claims of the deposit. This stalled the work on the project till March, 1991. The impasse was resolved by the Government giving the site a compound name of the two communities.

Based on the resolution, the Institute started her initial programme. Plant were hired to bulldoze about 2.1 hectares of land for the layout of the Brick Plant. The site preparation was completed in May 1991.

Theft Of Project Vehicle

When the issue of dispute over the land was settled, it was decided that the surveyors should be called back to work. It was during the time arrangement were being made for the movement of bulldozers to site that the vehicle was stolen by armed robbers. Appropriate steps were taken to recover the vehicle by reporting promptly to the police. The vehicle had a comprehensive insurance. The theft was reported to the insurance company. After full investigation and police report, the insurance company paid the Institute N58,000 (\$US 5,800) on the vehicle.

Construction

A two room site office was constructed after the site was bulldozed. Following this a layout was prepared for the 2.1 hectare cleared. The construction of the kiln started in earliest based on the set of drawings that were sent by PMRI.

All materials for the substructure were bought and delivered to site in October 1991. The substructure was completed in October. The bricks and other materials - ground clay and bricks were purchased and the construction of the superstructure started in February 1992.

During the construction, Mr. Rob Pacholock of PMRI visited the site and a letter was sent through him to the Centre on the cost implication of the project. A copy is attached for your perusal.

Stage of Work

The construction of the kiln has been completed with the exemption of the flame bridge which will be completed when the form work is completed. All materials for the firing in of the kiln has been purchased and the kiln is to be fired soon.

Remarks

The estimate of March 15th 1992 to completion presented to the Centre for consideration is \$61,000 CAD. As at July 1992, a total of N646,641 has been spent on materials, labour and accommodation of supervising staff. Also a sum of N184,470 will be needed for the purchase and installation of gadgets and firing of the kiln. Out of this the Institute has spent almost N48,000 in hiring vehicles to convey material and personnel to site during the construction period.

This brief is believed will form your basis of useful discussion with the Institute after visiting the site.

On behalf of the Institute, I welcome you to Nigeria. We hope your stay will be a memorable one.

Thanks.

Yours faithfully

A. O. Dirisu
Project Leader.

APPENDIX II

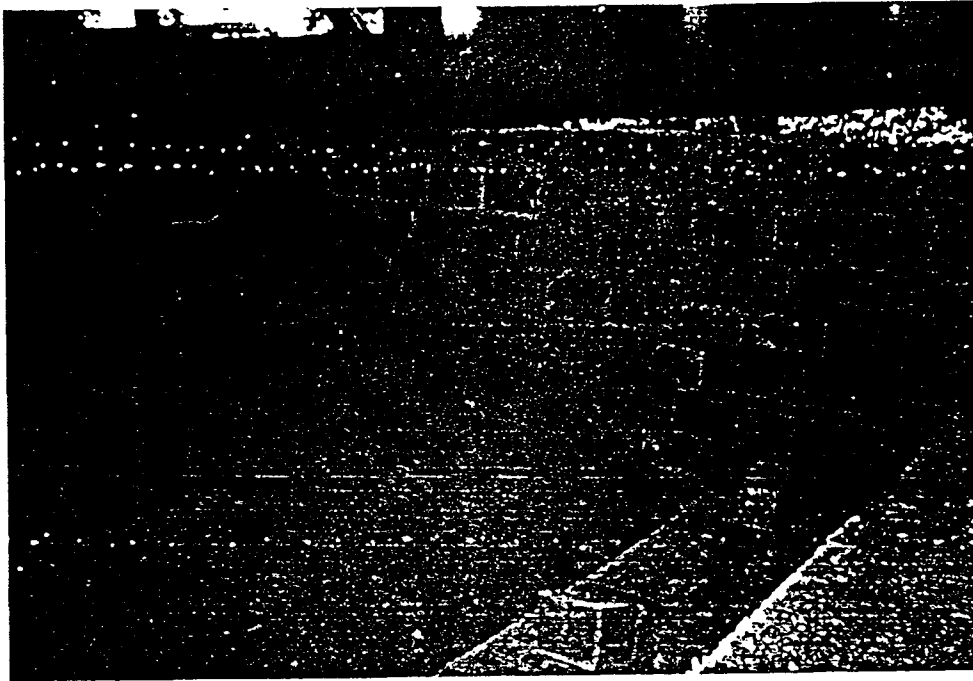
Photographs



Examples of Rural Housing.



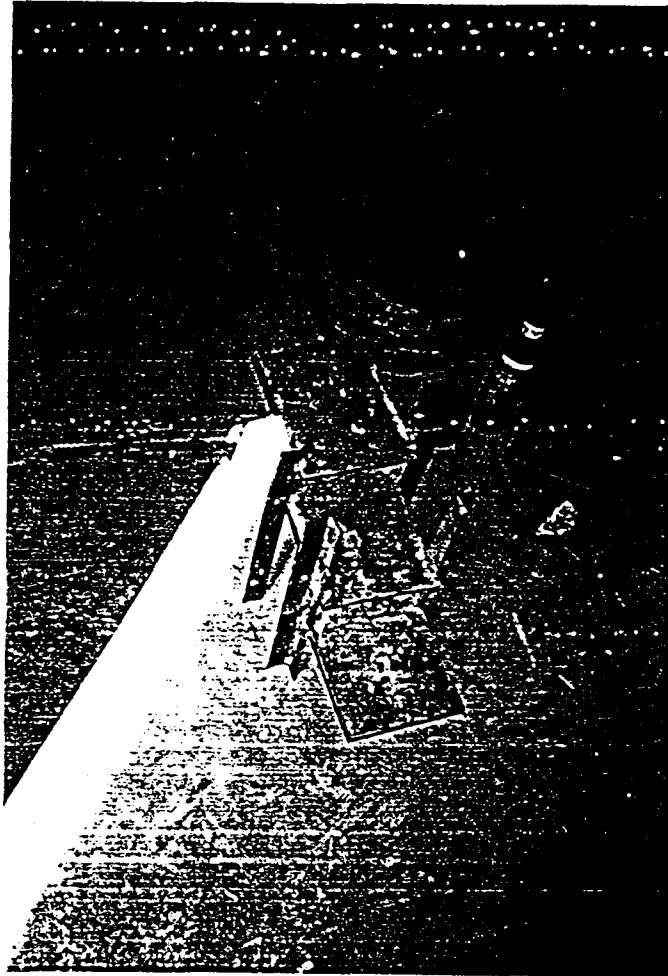
Project Leader Andrew Dirisu
at entrance to kiln.



Barrel vault roof of down-draft kiln.
(This location to be filled with crushed brick for heat insulation.)



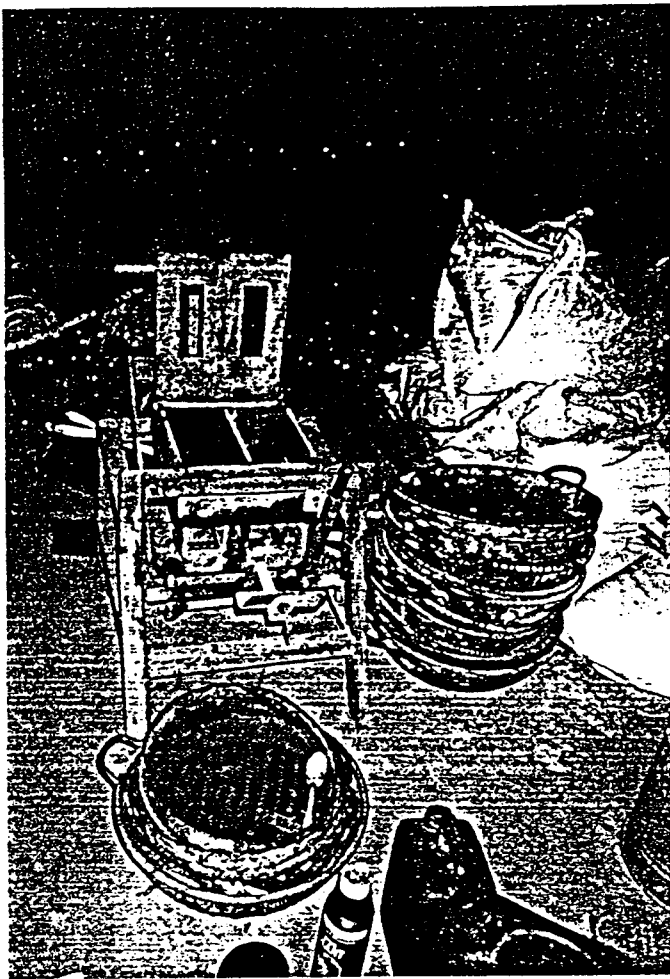
View of fire box (three per side of kiln).
This fire box can be fuelled with a variety of fuels.



Experimental drip plates to be placed in fire boxes.
To be used for waste engine oil fuel.



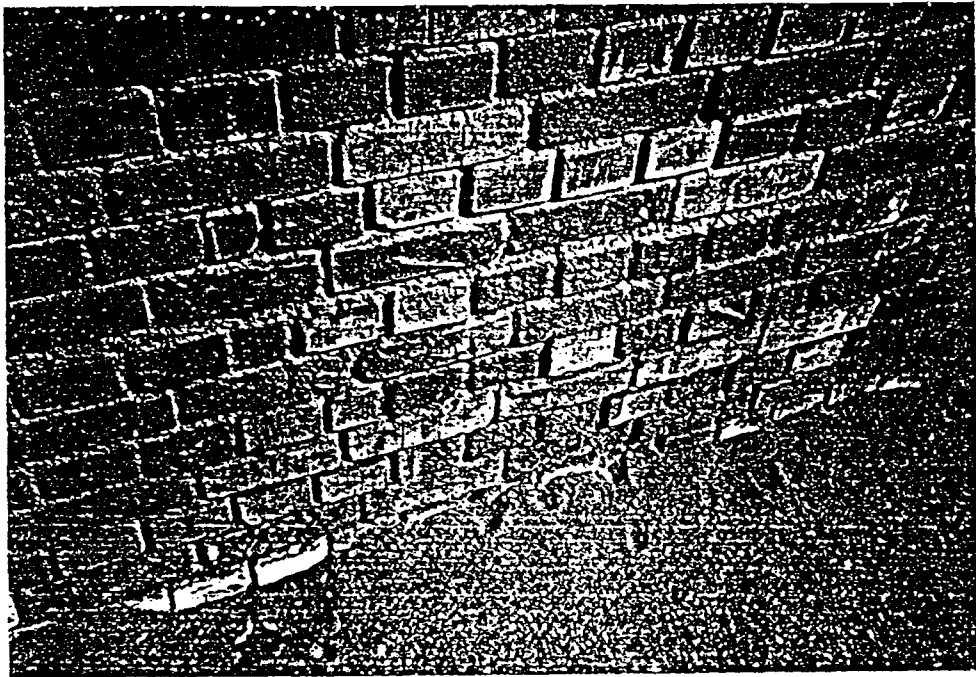
Low masonry wall heat deflector.
View from inside the kiln shown - two fire boxes beyond
the wall.



Manual Press
for bricks.



Raw dried brick (centre) prior to firing.



Surface brick deterioration
on front face of kiln.

APPENDIX III

Terms of Reference



1. Terms of Reference

Under this contract, the services required of you are as follows:

- a) an evaluation of the research methodology: scientific/technical merit; novel approach being pursued in terms of brick development. In particular, how do the novel aspects of the research differ from what is done by other researchers in the field, and how do they differ from similar research funded by IDRC and/or by other research funding agencies? How will the proposed research, in its essence and in terms of objectives and methodology, bring the known technology one step ahead of its previous knowledge level? Stated briefly, what is the essence of the novelty, innovation, or what are the special features of the research work undertaken which should, if successful, bring scientific and/or technical knowledge one step ahead?
- b) an evaluation of the project contribution in building up the research capacity and capability of the recipient institution in the countries concerned;
- c) an evaluation of the research institutions and research participation. Have they supported the project(s) in an adequate way?
- d) a review of the quality of the face to face collaborative aspects of the projects; the technical assistance content versus the collaborative aspect; the relationship between partners; their mode of collaboration and contribution to the overall execution and results of the projects;
- e) an evaluation of training activities for the utilization of the technical research results through dissemination, popularization and other means;
- f) an evaluation of the achievements of each project vis-a-vis their objectives;
- g) the impact of these projects on development;
- h) as well as the project by project evaluation described above, EES requires an overall evaluation of the approach to shelter problems via brick technology development. Is the approach chosen correct and appropriate in the case of each of the projects and in general? If so, why? If not, why not and how could it be made more appropriate?